ACTIVITY 6

RADON GAME

This activity lets students test what they may have heard or know about radon and challenges them to think about why radon is different in many ways from other indoor air pollutants. It is related to the "Making Decisions" warm-up. Related activities include "How Green Are We?" and "Breathing Room."

CRITICAL OBJECTIVES

- Identify the special aspects of radon pollution that distinguish it from other indoor air pollutants
- Identify correct from incorrect information about radon
- Devise methods for minimizing indoor radon levels

SKILLS

- Comparing
- Organizing
- Explaining
- Developing solutions

GUEST PRESENTERS

Guest presenters could include EPA environmental protection specialists, heating and ventilation technicians or engineers, or radon detection experts.

BACKGROUND

Radon is a naturally occurring radioactive gas, produced from the radioactive decay of uranium in rocks such as granite. Uranium and radon gas are widely distributed throughout the Earth's crust in virtually all types of rock and soil. Radon continually escapes from soils and rock into the atmosphere. Most of the radon in homes enters through cracks and holes in the foundation. Other sources include drinking water (especially well water) and bricks and concrete. As radon decays, it emits radioactive particles that could damage lung tissue and lead to lung cancer. An estimated 7,000 to 30,000 radon-related deaths occur each year in the United States (about 10 percent of the lung cancer deaths attributed to cigarette smoking). Radon detection is easy and inexpensive. The most common home detectors are the charcoal canister, alpha track monitor, and electret ion chamber. Common mitigation strategies include natural ventilation (such as open windows) on the lower levels, forced ventilation with or without heat recovery into (never out of) the lower levels, sealing entry points (such as foundation cracks and floor drains), and soil ventilation.

RELATED WARM-UP
G

REFER TO READING MATERIAL
"Radon"

TARGET GRADE LEVEL
7th - 8th

DURATION
20 minutes (additional time may be needed for the presenter to illustrate some of the answers, and display equipment if possible)

VOCABULARY
Radioactivity
Radon detector
Vacuum

MATERIALS
Student worksheet (or large chalkboard on which the information can be listed)

WORKSHEETS INCLUDED
1

Because the radon problem involves large numbers of private homes and varies greatly in concentration in these homes, the EPA and the states work together to address the problem. EPA developed a non-regulatory, technical assistance and public information program in 1985 to help citizens make informed decisions about radon. This program involves the states and over a dozen National organizations, such as the American Lung Association. In 1989, EPA published guidance for radon testing in schools and began a survey of schools Nationwide. Legislation requires federal agencies to test for radon in its own buildings. EPA developed the New Construction Demonstration Program and standards for use by states to develop building codes and issued guidance on techniques to reduce radon in schools. EPA also is involved in a voluntary program to test the proficiency of companies that measure indoor radon levels. (See reading material on "Radon.")

WHAT TO DO

1. Hand out a student worksheet or write the following points on the chalkboard (mix the true and false information if you use a blackboard):

2. Split the class into groups of two to five students, and give each student a worksheet. Give each group one extra worksheet and appoint someone in each group to record the group's answers on the extra worksheet. Ask each group to put a check mark by all of the information points on the worksheet that are true for radon. Discourage them

True for Radon	NOT True for Radon
• Not synthetic (occurs naturally) • Can't see, smell, or taste at any concentration • Radioactive gas • Comes from rocks and soil • Enters the house through cracks and holes in the foundation/basement • Is in the water supply, especially well water • Building materials like concrete and brick can be a source of the pollutant • Accumulates in basements and lower floors • Levels of the pollutant in one house can vary a lot from the house next door • Levels of the pollutant tend to be higher indoors when its cold outside • Emits particles (radioactive decay products) that damage lungs • Causes lung damage that leads to lung cancer • Only cigarette smoking causes more lung cancer deaths than this pollutant • Testing indoor air for the pollutant is easy and inexpensive • Using exhaust fans (stove top/bathroom) tends to increase the pollutant levels in the house • Using a fireplace tends to increase the pollutant levels in the house	• Synthetic (human-made) air pollutant • Made by manufacturing or refining it from other chemicals • Smells vaguely like ammonia • Smells slightly metallic • Can be produced in the house by a faulty heating unit like a furnace • Comes from petroleum • Can enter indoor air from improperly sealed canisters stored in the house • Found in some household cleaners • Levels of the pollutant tend to be higher indoors when the temperature outside is 70-80° F (21-27°C) • Health problems occur when the pollutant is used without proper ventilation • Causes liver damage that leads to liver cancer • Causes vomiting, diarrhea, sweating, cramps, coughing, and nerve disorders • Damages kidneys • Irritates eyes • Radon can only be detected or tested by using special equipment operated by professionals • Using exhaust fans that vent to the outdoors (stove top/bathroom) tends to decrease the pollutant levels in the house • Using a fireplace tends to decrease pollutant levels in the house

from guessing without a good explaNation. (If you have to use a chalkboard to list the information points, ask students to write their answers on paper.)

3. After each group has completed its list, ask one of the groups to read its first entry and explain the reason for the answer. Continue querying each group until all information points have been discussed. Ask the students why venting air out of a house, such as through a bathroom exhaust fan or fireplace, may increase indoor radon levels. Discuss the difference between natural ventilation, such as opening windows, and forcing air out of the house. You may keep score and determine a winner among the groups.

4. Ask the students to devise some methods for minimizing radon levels in a house or other building.

SUGGESTED EXTENSIONS (OPTIONAL)

- Hand out copies of the attached map of the United States that indicates where the greatest levels of radon are found. Have the students discuss what the map means. For example, should homes in areas with low levels of radon be tested?

- Invite a radon detection expert to demonstrate radon detection equipment and devices used to lower indoor radon levels.

- Build a model (using smoke, glass, or a plastic cylinder and a balloon) to illustrate the effect of a vacuum on the amount of radon seeping into a house.

SUGGESTED READING

Indoor Radon and Its Hazards. Seattle, WA: University of Washington Press (1987).

Lafavore, Michael. *Radon: The Invisible Threat (What It Is, How To Keep Your House Safe)*. Emmaus, PA: Rodale Press (1987).

"Radon Detectors: How to Find out if Your House Has a Radon Problem." *Consumer Reports*, 52 (July 1987) p. 440.

"Radon: Risk or Rubbish?" *Medical Update*, 14 (March 1991) p. 2.

Silberner, Joanne. "What To Do about Radon." *U.S. News and World Report*, 105 (26 September 1988) p. 62.

Stone, Richard. "New Radon Survey: No Smoking Gun." *Science* (28 January 1994)

U.S. EPA. *A Citizen's Guide to Radon*. Washington, DC: U.S. EPA, Office of Air and Radiation EPA/402/K-92/001 (1992).

STUDENT WORKSHEET 1

RADON

POLLUTANT DESCRIPTIONS

Place a check mark by the following points that apply to radon. If you guess, you should have a good reason for your answer.

___ 1. Synthetic (human-made) gas
___ 2. Comes from automobile exhaust
___ 3. Radioactive gas
___ 4. Made by manufacturing or refining it from other chemicals
___ 5. Smells vaguely like ammonia
___ 6. Smells slightly metallic
___ 7. Can't see, smell, or taste at any concentration
___ 8. Comes from rocks and soil
___ 9. Comes from petroleum
___10. Can be produced in the house by a faulty heating unit like a furnace
___11. Enters the house through cracks and holes in the foundation/basement
___12. Can enter the house from improperly sealed canisters stored in the house
___13. Found in some household cleaners
___14. Is in the water supply, especially well water
___15. Building materials like concrete and brick can be a source of the pollutant
___16. Accumulates in basements and lower floors
___17. Levels of the pollutant in one house can vary a lot from the house next door
___18. Levels of the pollutant tend to be higher indoors when it's cold outside
___19. Levels of the pollutant tend to be higher indoors when the outside temperature is 70-80° F (21-27° C)
___20. Health problems occur when the pollutant is used without proper ventilation
___21. Only cigarette smoking causes more lung cancer deaths than this pollutant
___22. Causes liver damage that leads to liver cancer
___23. Only carbon tetrachloride causes more deaths from liver disease than this pollutant
___24. Causes vomiting, diarrhea, sweating, cramps, coughing, and nerve disorders
___25. Emits particles (radioactive decay products) that damage lungs
___26. Damages kidneys
___27. Causes lung damage that could lead to lung cancer
___28. Irritates eyes
___29. Testing indoor air for the pollutant is easy and inexpensive
___30. Radon can only be detected/tested by using special equipment operated by porfessionals
___31. Using exhaust fans (stove top/bathroom) tends to decrease the pollutant levels in the house
___32. Using exhaust fans (stove top/bathroom) tends to increase the pollutant levels in the house
___33. Using a fireplace tends to increase the pollutant levels in the house
___34. Using a fireplace tends to decrease the pollutant levels in the house

STUDENT HANDOUT

RADON

AREAS WITH POTENTIALLY HIGH RADON LEVELS

TEACHER FACT SHEET

THE RADON GAME

FACTS ABOUT THE MAP OF AREAS WITH POTENTIALLY HIGH RADON LEVELS

PURPOSE:

- EPA is required to identify and list areas of U.S. with the potential for elevated indoor radon levels.

- EPA's Map of Radon Zones assigns each of the 3,141 counties in the United States to one of three zones based on radon potential:

  - Zone 1 counties have a predicted average indoor screening level greater than 4 pCi/L (dark grey)
  - Zone 2 counties have a predicted average screening level between 2 and 4 pCi/L (light grey)
  - Zone 3 counties have a predicted average screening level less than 2 pCi/L (white)

AUDIENCES:

- National, state, and local governments and organizations – to assist in targeting their radon program activities and resources.

- Building code officials – to help determine areas that are the highest priority for adopting radon-resistant building practices.

MAP DEVELOPMENT:

- Five factors were used to determine radon potential:
  - indoor radon measurements, geology, aerial radioactivity, soil permeability and foundation type

- Radon potential assessment is based on geologic provinces:
  - Radon Index Matrix is the quantitative assessment of radon potential
  - Confidence Index Matrix shows the quantity and quality of the data used to assess radon potential

- Geologic provinces were adapted to county boundaries for the Map of Radon Zones.

MAP DOCUMENTATION:

- Detailed booklets are available for each state that discuss the matrices and data used.

- State booklets are an essential tool in employing the map's information.

IMPORTANT POINTS:

- All homes should test for radon, regardless of geographic location or zone desigNation.

- There are many thousands of individual homes with elevated radon levels in Zones 2 and 3. Elevated levels can be found in Zone 2 and Zone 3 counties.

- All users of the map should carefully review the map documentation for information on within-county variations in radon potential and supplement the map with locally available information before making any decisions.

- The map is not to be used instead of testing during real estate transactions.